

Scientific and Engineering Research Facilities

at Colleges
and Universities
1996



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Highlights . . .

- ◆ In 1996, science and engineering (S&E) research accounted for 136 million net assignable square feet (NASF) in the nation's 565 research-performing colleges and universities. The top 100 universities in research and development (R&D) expenditures accounted for 72 percent of all S&E research space in 1996, and 80 percent of all R&D dollars in 1994, the most recent year for which data were available.
- ◆ S&E research space increased since 1988 at an annual average rate of about 2.4 percent, from 112 million NASF to 136 million NASF in 1996. Other National Science Foundation (NSF) surveys show that academic R&D spending grew in constant 1995 dollars at an average annual rate of approximately 4 percent from 1988 to 1994, the most recent year for which data are available.
- ◆ At least half of research performing institutions reported inadequate amounts of research space in the biological sciences outside of medical schools, the physical sciences, engineering, the agricultural sciences, and the medical sciences, both within and outside medical schools.
- ◆ In 1996, 18 percent of the S&E research space at research-performing institutions was rated as needing major renovation or replacement. Altogether, 24.5 million NASF of S&E research space required major renovation or replacement.
- ◆ In fiscal years 1994-1995, research-performing colleges and universities began S&E research construction projects costing \$2.8 billion, representing a continued decline in the construction of S&E research space. Institutions began construction projects valued at \$3.0 billion (in constant 1995 dollars) in 1992-1993, and \$3.4 billion in 1990-1991.
- ◆ Expenditures for repair/renovation projects increased from \$905 million in fiscal years 1992-1993 to \$1.1 billion in 1994-1995, an increase of 17 percent in constant 1995 dollars.
- ◆ The main source of construction funding was state and local governments (\$1.2 billion, or 43 percent of all construction funding). Direct Federal funding for construction declined in constant 1995 dollars from \$537 million in 1990-1991 to \$207 million in 1994-1995. Funds from the Federal government used to defray the indirect costs of conducting Federally-funded research are counted as institutional funds.
- ◆ Repair/renovation projects were most likely to be funded through institutional funds (\$433 million, or 41 percent of all repair/renovation). Federal funding of repair/renovation increased in constant 1995 dollars from \$55 million in 1990-1991 to \$111 million in 1994-1995.
- ◆ The total estimated cost for deferred S&E research construction and repair/renovation projects in 1996 was \$9.3 billion, including both projects that were identified in approved institutional plans and those that were not. Over three-quarters of all deferred capital project expenditures (\$7.4 billion) were included in institutional plans.
- ◆ In addition, colleges and universities estimated a total of \$2.5 billion in deferred repair and renovation costs for projects affecting central campus infrastructure. It is estimated, conservatively, that \$.7 billion of this amount might be attributed to S&E research needs. Combining this \$.7 billion with the \$9.3 billion in deferred construction and repair/renovation projects yields a total of \$10 billion in deferred research facilities and infrastructure needs.

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Foreword

In the last 50 years, America has relied increasingly on the scientific and technological knowledge generated at its colleges and universities. We have come to expect that the highly trained scientists and engineers in academia would generate new knowledge and make possible innovations and new developments for our national security and our general prosperity. We have been confident that a strong national investment in our academic research and education enterprise would reward us multifold. That confidence has been justified by unforeseen benefits and a continuous stream of new knowledge and research.

A critical ingredient in these research achievements has been state-of-the-art facilities and infrastructure. From 1960 to the early 1980s, we as a nation paid careful attention to updating and expanding this backbone of the research enterprise. By the mid 1980s, however, concern spread about the rising neglect and obsolescence of our once highly acclaimed science and engineering infrastructure. Many speculated that this deterioration would limit the quality and quantity of our research in the future.

At this juncture, the Congress in Section 108 of the National Science Foundation Authorization Act for Fiscal Year 1986 (42 U.S.C. 1886) directed the National Science Foundation to collect data that would provide an accurate and comprehensive picture of research facility conditions and needs at our colleges and universities. A pilot study published in 1986 provided the initial background for a more comprehensive report.

In accord with the Congressional mandate, we have conducted biennial surveys of our research facilities. This report presents the findings of the sixth biennial survey. It includes a broad quantitative depiction of existing research facilities, current construction and renovation initiatives, funding sources, plans for future projects, and identification of deferred projects.

The information contained in this survey was not intended to answer the policy questions related to the nation's research infrastructure problems. Despite that, it can provide accurate and useful information for such a policy dialogue among all the proponents of a healthy and productive science and engineering research enterprise for the nation.

Neal Lane
Director
National Science Foundation

Acknowledgments

The 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities was developed and guided by Ann T. Lanier, Senior Science Resources Analyst, Education and Human Resources Program (EDU), Division of Science Resources Studies (SRS), National Science Foundation (NSF), under the direction of Mary J. Golladay, EDU Program Director. Guidance and review were provided by Kenneth M. Brown, Director, SRS, Al Tupek, Acting Director of SRS, and Cora B. Marrett, Assistant Director for Social, Behavioral, and Economic Sciences (SBE), NSF. Review and comments were provided by Carolyn B. Arena, Project Director for the Academic Instrumentation Survey, SRS, and Nathaniel G. Pitts, Director, Office of Science and Technology Infrastructure, NSF.

The National Institutes of Health (NIH) co-sponsored the project and provided significant financial support as well as guidance and review, under the direction of Paul Seder, NIH Office of Science Policy and Technology Transfer.

An Expert Advisory Panel contributed to the survey design, the analysis plan, and the review of this report. Members included the following:

- ◆ James E. Swartz, Professor of Chemistry, Grinnell College
- ◆ Jacqueline Wender, Associate Provost for Facilities Planning, Stanford University
- ◆ Karen Yarbrough, Vice President for Research and Planning, The University of Southern Mississippi
- ◆ Bruce Gillars, Facilities Coordinator, University of Utah
- ◆ Robert McGhee, Director of Research Facility Planning, Howard Hughes Institute
- ◆ William R. Tibbs, Jr., Principal, Tibbs Associates
- ◆ Earl S. Richardson, President, Morgan State University
- ◆ Jaleh Daie, Senior Science Advisor for Academic Affairs, University of Wisconsin Madison

In addition, NSF sought advice on the development of the survey from higher education association and university representatives, who graciously provided information of considerable importance to the success of the project.

Administrators at the higher education associations and societies who reviewed and commented on the report included:

- ◆ Marvin E. Ebel, Council on Governmental Relations (COGR)
- ◆ Howard Gobstein, Federal Relations Office, Michigan State University
- ◆ Wayne Leroy, Association of Physical Plant Administrators of Universities and Colleges
- ◆ Jeanne Narum, Independent Colleges Offices (ICO)
- ◆ Jerold Roschwalb, National Association of State Universities and Land-Grant Colleges (NASULGC)
- ◆ John G. Stevens, Council on Undergraduate Research (CUR)

The 1996 survey was conducted by The Gallup Organization of Rockville, Maryland, under contract to NSF (Contract Number SRS-9317363). Gregory Gaertner served as Gallup's overall Project Director; Jennifer Spielvogel led field operations; Manas Chattopadhyay was the project statistician; and Yonghe Yang directed the data processing for the survey. Alison Cooper and Betty Garrison managed the production of the report.

Subcontractors for the project were Pelavin Research Institute (PRI) and the American Institutes for Research (AIR). Rita Kirshstein headed the Pelavin team, Susan Kleimann directed the AIR contributors, and Ray Varisco edited the report.

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Table of Contents

	Page
Executive Summary	xv
Introduction	xxix
<i>Chapter 1</i> Amount and Distribution of Research Space	1-1
Highlights	1-1
Background	1-2
The Survey Questions	1-2
Data Considerations	1-2
Findings.....	1-3
<i>Chapter 2</i> Adequacy and Condition of Research Space	2-1
Highlights	2-1
Background	2-2
The Survey Questions	2-2
Data Considerations	2-3
Findings.....	2-3
<i>Chapter 3</i> The Construction of S&E Research Space	3-1
Highlights	3-1
Background	3-2
The Survey Questions	3-2
Data Considerations	3-3
Findings.....	3-3

<i>Chapter 4</i>	The Repair/Renovation of S&E Research Space	4-1
	Highlights	4-1
	Background	4-2
	The Survey Questions	4-2
	Data Considerations	4-2
	Findings.....	4-3
<i>Chapter 5</i>	Funding of Research Facilities Projects	5-1
	Highlights	5-1
	Background	5-2
	The Survey Question	5-2
	Data Considerations	5-2
	Findings.....	5-3
<i>Chapter 6</i>	Deferred Construction and Repair/Renovation	6-1
	Highlights	6-1
	Background	6-2
	The Survey Questions	6-2
	Data Considerations	6-3
	Findings.....	6-4
<i>Chapter 7</i>	Historically Black Colleges and Universities	7-1
	Highlights	7-1
	Background	7-2
	The Survey Questions	7-2
	Data Considerations	7-2
	Findings.....	7-3
<i>Chapter 8</i>	Nondoctorate-Granting Institutions	8-1
	Highlights	8-1
	Background	8-2

	The Survey Questions	8-2
	Data Considerations	8-2
	Findings.....	8-3
<i>Chapter 9</i>	Animal Care Facilities	9-1
	Highlights	9-1
	Background	9-2
	The Survey Questions	9-2
	Data Considerations	9-2
	Findings.....	9-3
<i>Appendix A</i>	Technical Notes	A-1
<i>Appendix B</i>	List of Sampled Institutions	B-1
<i>Appendix C</i>	Survey Questionnaire	C-1
<i>Appendix D</i>	References	D-1
<i>Appendix E</i>	Validation of Estimates of Deferred Project Costs	E-1
<i>Appendix F</i>	Detailed Statistical Tables	F-1

List of Text Tables

Table 1-1	Amount of science and engineering (S&E) research space by institution type: 1996	1-4
Table 1-2	Science and engineering (S&E) research space utilization: 1996	1-5
Table 1-3	Trends in the amount of science and engineering (S&E) research space by institution type: 1988-1996	1-6
Table 1-4	Trends in the amount of leased science and engineering (S&E) research space by institution type: 1988-1996	1-7
Table 1-5	Percentage of institutions with science and engineering (S&E) research space by institution type and field: 1996	1-8

Table 1-6	Trends in the amount of science and engineering (S&E) research space by field: 1988-1996	1-9
Table 1-7	Comparison of the distribution of 1994 research and development (R&D) expenditures and 1996 science and engineering (S&E) research space by field	1-10
Table 2-1	Percentage of institutions reporting inadequate amounts of science and engineering (S&E) research space in existing fields by institution type and field: 1996	2-4
Table 2-2	Institutional assessment of the quality and condition of science and engineering (S&E) research space by institution type: 1996	2-5
Table 2-3	Trends in the amount of science and engineering (S&E) research space requiring repair/renovation or replacement by field: 1988-1996	2-6
Table 3-1	Trends in the net assignable square feet (NASF) of science and engineering (S&E) research space under construction by institution type: 1986-1995	3-4
Table 3-2	Trends in expenditures to construct science and engineering (S&E) research facilities by institution type: 1986-1995	3-5
Table 3-3	Trends in expenditures for capital projects to construct science and engineering (S&E) research facilities by field: 1986-1997	3-7
Table 3-4	Scheduled construction expenditures for science and engineering (S&E) research space and central campus infrastructure by institution type: 1996-1997	3-8
Table 3-5	Trends in the percentage of institutions starting capital projects to construct science and engineering (S&E) research facilities by institution type: 1986-1997	3-10
Table 3-6	Trends in the percentage of institutions starting projects to construct science and engineering (S&E) research facilities by field: 1986-1997	3-11
Table 4-1	Trends in expenditures for capital projects costing over \$100,000 to repair/renovate science and engineering (S&E) research facilities by institution type: 1986-1995	4-3

Table 4-2	Trends in expenditures for science and engineering (S&E) research facilities repair/renovation projects costing less than \$100,000 by institution type: 1990-1995	4-5
Table 4-3	Science and engineering (S&E) repair/renovation expenditures as a proportion of total capital project expenditures by institution type: 1990-1995	4-6
Table 4-4	Trends in expenditures for capital projects to repair/renovate science and engineering (S&E) research facilities by field: 1986-1997	4-7
Table 4-5	Scheduled repair/renovation expenditures for science and engineering (S&E) research space and central campus infrastructure by institution type: 1996-1997	4-8
Table 4-6	Trends in the percentage of institutions starting capital projects to repair/renovate science and engineering (S&E) research facilities by institution type: 1986-1997	4-9
Table 4-7	Trends in percentage of institutions starting capital projects to repair/renovate science and engineering (S&E) research facilities by field: 1986-1997	4-10
Table 5-1	Trends in the sources of funding for construction of science and engineering (S&E) research facilities: 1990-1995	5-4
Table 5-2	Trends in the sources of funding for repair/renovation of science and engineering (S&E) research facilities: 1990-1995	5-4
Table 5-3	Trends in the sources of funding for construction of science and engineering (S&E) research facilities at public institutions: 1990-1995	5-5
Table 5-4	Trends in the sources of funding for construction of science and engineering (S&E) research facilities at private institutions: 1990-1995 ...	5-8
Table 5-5	Trends in the sources of funding for repair/renovation of science and engineering (S&E) research facilities at public institutions: 1990-1995 ...	5-11
Table 5-6	Trends in the sources of funding for repair/renovation of science and engineering (S&E) research facilities at private institutions: 1990-1995	5-13

Table 6-1	Expenditures for deferred capital projects to construct or repair/renovate science and engineering (S&E) research facilities by institution type, type of project, and whether project was included in institutional plans	6-4
Table 6-2	Change in deferred science and engineering (S&E) construction and repair/renovation needs reported in institutional plans: 1994 and 1996	6-7
Table 6-3	Consistency in reporting deferred construction and repair/renovation needs: 1994 and 1996	6-9
Table 6-4	Expenditures for deferred capital projects to construct or repair/renovate central campus infrastructure by institution type, type of project, and whether project was included in institutional plans	6-11
Table 7-1	Trends in the amount of space assigned to science and engineering (S&E) fields at Historically Black Colleges and Universities: 1992-1996 ..	7-4
Table 7-2	Trends in the percentage of Historically Black Colleges and Universities with science and engineering (S&E) research space assigned and the amount of S&E research space by field: 1992-1996	7-5
Table 7-3	Trends in the percentage of Historically Black Colleges and Universities reporting inadequate amounts of science and engineering (S&E) research space in existing fields: 1992-1996	7-6
Table 7-4	Trends in the percentage and amount of science and engineering (S&E) research space in Historically Black Colleges and Universities considered to require major renovation or replacement: 1992-1996	7-7
Table 7-5	Trends in the construction of science and engineering (S&E) research projects at Historically Black Colleges and Universities by field: 1990-1995	7-8
Table 7-6	Trends in the repair/renovation of science and engineering (S&E) research projects at Historically Black Colleges and Universities by field: 1992-1996	7-9
Table 7-7	Trends in the sources of funding for construction at Historically Black Colleges and Universities: 1990-1995	7-10

Table 7-8	Trends in the sources of funding for repair/renovation at Historically Black Colleges and Universities: 1990-1995	7-11
Table 7-9	Expenditures for deferred capital projects to construct or repair/renovate science and engineering (S&E) research facilities at HBCUs by institution type, type of project, and whether project was included in institutional plans	7-12
Table 8-1	Distribution of science and engineering (S&E) space at nondoctorate-granting institutions: 1996	8-4
Table 8-2	Percentage of nondoctorate-granting institutions with science and engineering (S&E) research space and the amount of S&E research space by field	8-5
Table 8-3	Percentage of nondoctorate-granting institutions reporting inadequate amounts of science and engineering (S&E) research space in existing fields	8-6
Table 8-4	Percentage and amount of science and engineering (S&E) research space in nondoctorate-granting institutions considered to require major renovation or replacement: 1996	8-7
Table 8-5	Expenditures to construct science and engineering (S&E) research space in nondoctorate-granting institutions by field: 1994-1995	8-8
Table 8-6	Expenditures to repair/renovate science and engineering (S&E) research space in nondoctorate-granting institutions by field: 1994-1995	8-9
Table 8-7	Sources of funding to construct science and engineering (S&E) research space at nondoctorate-granting institutions: 1994-1995	8-10
Table 8-8	Sources of funding to repair/renovate science and engineering (S&E) research space at nondoctorate-granting institutions: 1994-1995	8-11
Table 8-9	Expenditures for deferred capital projects to construct or repair/renovate science and engineering (S&E) research facilities at nondoctorate-granting institutions by institution type, type of project, and whether project was included in institutional plans	8-12

Table 9-1	Amount and distribution of laboratory animal facilities by institution type: 1996	9-3
Table 9-2	Amount and distribution of laboratory animal space by use and institution type: 1996	9-4
Table 9-3	Percentage of animal care research space meeting government regulations by institutional type: 1996	9-5
Table 9-4	Scheduled construction and repair/renovation for laboratory animal facility improvement: 1996-1997	9-6
Table 9-5	NASF scheduled for construction and repair/renovation of laboratory animal facilities: 1996-1997	9-7

List of Executive Summary Figures

Figure 1	Number of Research-Performing Institutions by Institution Type	xvi
Figure 2	Total Net Assignable Square Feet of S&E Research Space by Institution Type	xvii
Figure 3	Trends in S&E Construction Expenditures, by Institution Type: 1986-1995	xix
Figure 4	Trends in S&E Repair/Renovation Expenditures, by Institution Type: 1986-1995	xx
Figure 5	Trends in the Sources of Funding for S&E Research Construction Projects at Public Institutions: 1990-1995	xxi
Figure 6	Trends in the Sources of Funding for S&E Research Construction Projects at Private Institutions: 1990-1995	xxii
Figure 7	Unfunded Science and Engineering (S&E) Research Facilities Needs Included in Institutional Plans: 1996	xxiv

List of Chapter Figures

Figure 1-1	Allocation of Total Academic Space by Type of Institution	1-4
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Figure 3-1	Trends in S&E Construction Expenditures, by Institution Type: 1986-1995	3-6
Figure 4-1	Trends in S&E Repair/Renovation Expenditures, by Institution Type: 1986-1995	4-4
Figure 5-1	Trends in the Sources of Funding for S&E Research Construction Projects at Public Institutions: 1990-1995	5-6
Figure 5-2	Trends in the Sources of Funding for S&E Research Construction Projects at Private Institutions: 1990-1995	5-9
Figure 6-1	Unfunded Science and Engineering (S&E) Research Facilities Needs Included in Institutional Plans: 1996	6-6
Figure 7-1	Trends in Funding for Construction at HBCUs	7-8

Executive Summary

Overview

On a biennial basis since 1986, the National Science Foundation (NSF) has collected data on issues related to science and engineering (S&E) research facilities in our nation's colleges and universities. This effort stems from hearings held in the mid-1980s in both the U.S. House of Representatives and the Senate. Recognizing that the condition of S&E research facilities in higher education institutions posed a "serious and ongoing problem," Congress mandated that NSF gather data and report results to Congress:

The National Science Foundation is authorized to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities and colleges. The needs of universities by major field of science and engineering, for construction and modernization of research laboratories, including fixed equipment and major research equipment, shall be documented. University expenditures for the construction and modernization of research facilities, the sources of funds, and other appropriate data shall be collected and analyzed. The Foundation, in conjunction with other appropriate Federal agencies, shall report the results to Congress. The first report shall be submitted to Congress by September 1, 1986 (42 U.S.C. 1886).

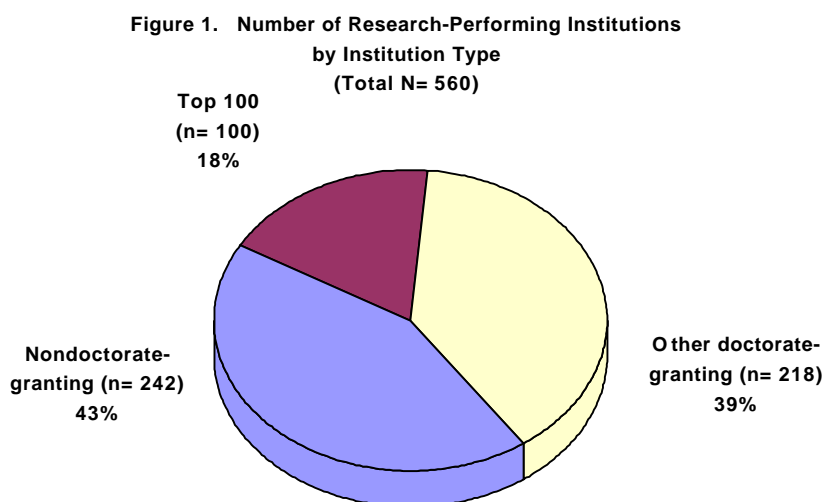
This executive summary presents the major findings from the 1996 survey and compares them with those from earlier efforts. A brief description of the study methods precedes a discussion of several issues that focus on the S&E research facilities in research-performing colleges and universities, including:

- ◆ The amount of space available for S&E research in our nation's colleges and universities;
- ◆ The adequacy of this space and its condition;
- ◆ The construction of S&E research space as well as the repair/renovation of existing space;
- ◆ The source of funding for repairs and construction; and
- ◆ The research facility needs of colleges and universities.

Profiles of Historically Black Colleges and Universities (HBCUs) and a select group of institutions that focus on undergraduate education follow the summary of the above issues. The last section of the report examines issues that relate to animal research facilities.

Survey Methods

The 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities was mailed to a sample of 314 institutions in the fall of 1995. That sample represented 560 colleges and universities with either research and development (R&D) expenditures of \$50,000 or more in 1991, or HBCUs with any R&D expenditures in that year.¹ Of those 560 research-performing institutions, 242 (43 percent) were nondoctorate-granting, 100 (18 percent) were the institutions with the largest R&D expenditures (referred to throughout the report as the “top 100”) and 218 (39 percent) were other doctorate-granting (Figure 1).



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

The institutions sampled in 1996 were the same as those sampled in 1994, and those institutions that responded in 1994 were sent a computer-generated facsimile of their previous responses. All institutions were given the option to respond to the survey via computer disk, and 30 percent used this option. Extensive telephone follow-up resulted in a 97 percent response rate overall, with 100% participation from the top 100 and from Historically Black Colleges and Universities (HBCUs). Telephone contacts were also used to resolve incomplete and inconsistent responses. (See Appendix A, “Technical Notes,” for a detailed description of the sampling procedures and data-collection methods.)

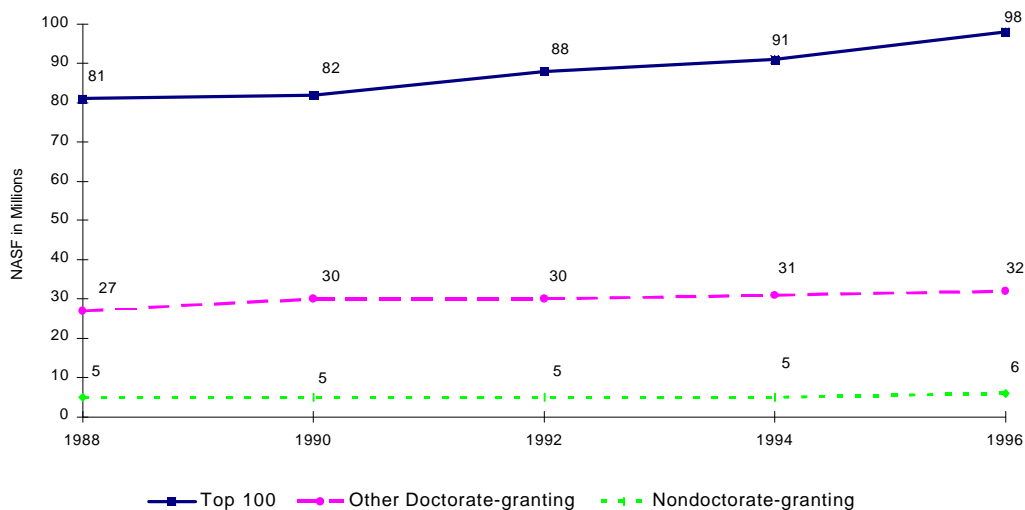
¹ Throughout this report, these 560 colleges and universities are referred to as “research-performing” institutions.

The Amount of S&E Research Space in Colleges and Universities

In 1996, S&E fields occupied about 285 million net assignable square feet (NASF) of space in research-performing colleges and universities, with 136 million NASF devoted to research.² The top 100 institutions occupied 72 percent of this S&E research space (about 98 million NASF). In 1994 (the most current year for which data were available), the top 100 universities accounted for 80 percent of all R&D expenditures.

The amount of S&E research space has increased steadily since 1988, from 112 million NASF in that year to 136 million NASF in 1996. Most growth occurred at the top 100 universities, where S&E research space grew 21 percent (from 81 million NASF in 1988 to 98 million NASF in 1996) (Figure 2).

Figure 2. Total Net Assignable Square Feet of S&E Research Space by Institution Type



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Ninety percent of all institutions had S&E research space in the biological sciences outside of medical schools and 88 percent had S&E research space in the physical sciences. Those fields occupied 19 million NASF of S&E research space and 18 million NASF, respectively. In 1996, engineering and agricultural sciences

² In this report, research is defined as "...all research and development activities of an institution that are budgeted and accounted for." Research can be funded by the Federal government, state governments, foundations, corporations, and other sources. Research space refers to the net assignable square footage of space within research facilities (buildings) in which research activities take place. Multipurpose space, such as an office, is prorated to reflect the proportion of use devoted to research activity.

contained the most S&E research space; and each of those fields occupied 22 million NASF of space. However, only 51 percent of all research-performing institutions reported S&E research space in engineering, and only 20 percent reported space in the agricultural sciences.

The Adequacy of S&E Research Space

Institutions assessed the adequacy of S&E research space for each field, and at least half reported inadequate amounts in the biological sciences outside of medical schools, the physical sciences, engineering, the agricultural sciences, and the medical sciences, both within and outside medical schools. ³

The Condition of S&E Research Space

In 1996, 37 percent of the S&E research space at research-performing institutions was rated as suitable for use in the most scientifically sophisticated research, 44 percent was considered effective for most levels of research, and the remaining 18 percent was thought to need major renovation or replacement. Altogether, 24.5 million NASF of S&E research space required major renovation or replacement.

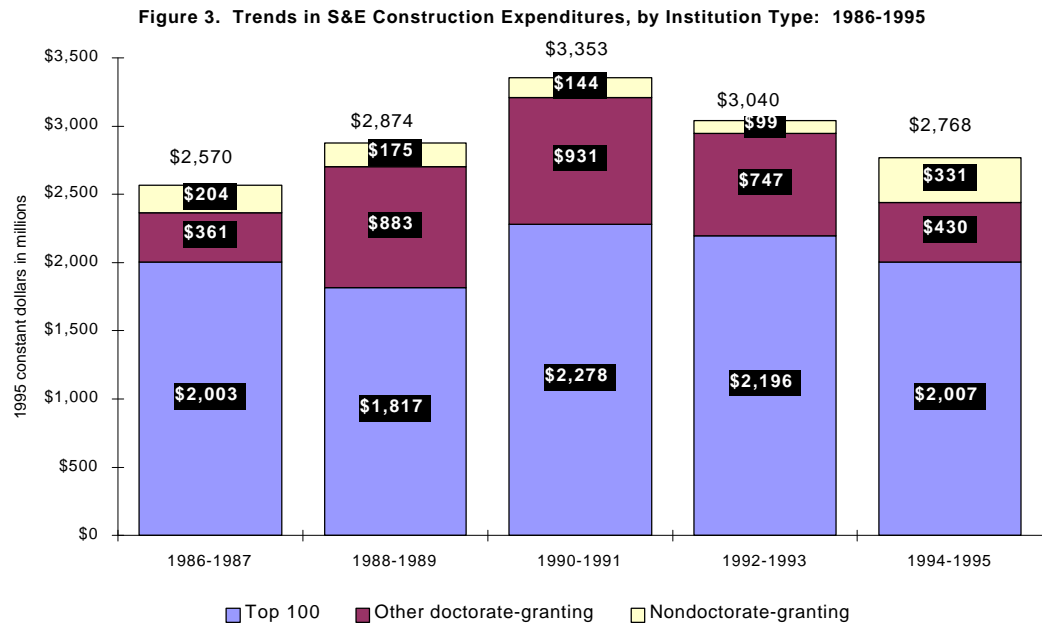
Since 1988, the amount of research space requiring repair/renovation or replacement in many of the S&E fields has increased. In the agricultural sciences, the amount increased from 3.6 million NASF in 1988, to 5.3 million in 1996. The amount of S&E research space in the biological sciences outside of medical schools requiring repair/renovation or replacement increased from 2.4 million NASF in 1988, to 3.4 million in 1996. Engineering space in this condition grew from 2.2 million NASF to 4.0 million NASF.

The Construction of S&E Research Space

In fiscal years 1994-1995, research-performing colleges and universities began S&E research construction projects costing \$2.8 billion, representing a continued decline in the construction of S&E research space. In the 1992-1993 fiscal years, institutions

³Only those institutions that had existing S&E research space in a field reported whether or not the amount was adequate.

began construction projects valued at \$3.0 billion (in constant 1995 dollars)⁴, and in the previous two fiscal years, S&E research construction projects cost \$3.4 billion. This decline since the 1990-1991 fiscal years occurred in both the top 100 research performers and other doctorate-granting institutions. For nondoctorate-granting institutions, S&E research construction projects begun in the 1994-1995 fiscal years increased over the previous two fiscal years (Figure 3).



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

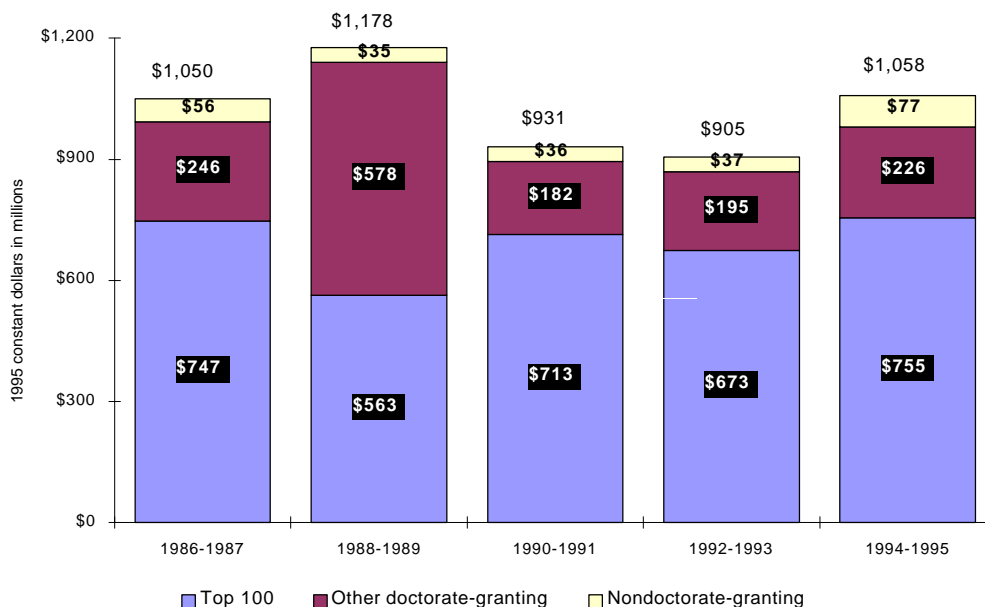
More than one-half of the \$2.8 billion in construction spending was accounted for by engineering (\$575 million), the medical sciences in medical schools (\$525 million), and the physical sciences (\$426 million). Institutions spent the next largest amounts of money to construct research space in the biological sciences outside of medical schools (\$388 million), the biological sciences in medical schools (\$226 million), and the agricultural sciences (\$150 million). The largest increase in spending for the construction of S&E research space between fiscal years 1992-1993 and 1994-1995 occurred in engineering (from \$309 million to \$575 million).

⁴ All dollars reported have been adjusted to 1995 constant dollars, using the Bureau of the Census's Fixed-Weighted Price Index for Construction. See Table A-5 in Appendix A.

The Repair/Renovation of Existing S&E Research Space

Expenditures for repair/renovation projects costing over \$100,000 increased between fiscal years 1992-1993 and 1994-1995. In fiscal years 1992-1993, all research-performing institutions spent a total of \$905 million. In fiscal years 1994-1995, the same institutions spent \$1.1 billion, an increase of 17 percent in constant dollars (Figure 4). Spending at doctorate-granting institutions increased from \$868 million to \$981 million. At nondoctorate-granting institutions, spending more than doubled, from \$37 million to \$77 million.

Figure 4. Trends in S&E Repair/Renovation Expenditures, by Institution Type: 1986-1995



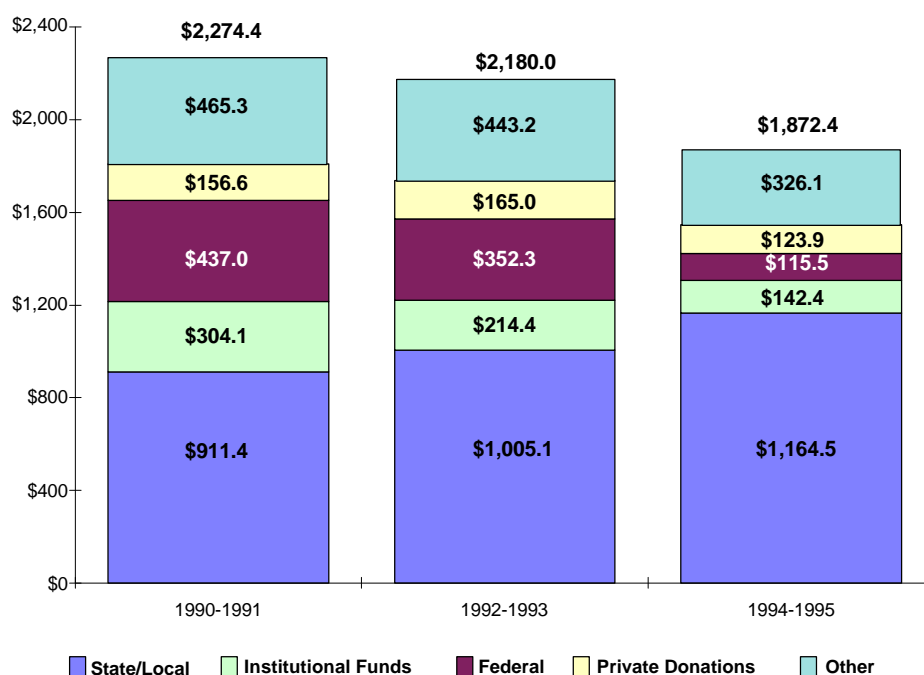
SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Institutions spent more to repair/renovate S&E research space in the medical sciences in medical schools (\$226 million) than in any other field during fiscal years 1994-1995. Repair/renovation expenditures for biology and the medical sciences in medical schools represented approximately 31 percent of all repair/renovation expenditures in fiscal years 1994-1995. Repair/renovation expenditures for those fields, however, were lower in both constant dollar terms and as a proportion of total repair/renovation spending in fiscal years 1994-1995 than in fiscal years 1992-1993.

The Funding of Research Facilities Projects

Public and private research-performing institutions fund the construction of S&E research facilities differently. For all three types of public institutions--the top 100, other doctorate-granting, and nondoctorate-granting--state and local governments provided the major funding for constructing research facilities in fiscal years 1994-1995 (Figure 5).

Figure 5. Trends in the Sources of Funding for S&E Research Construction Projects at Public Institutions: 1990-1995

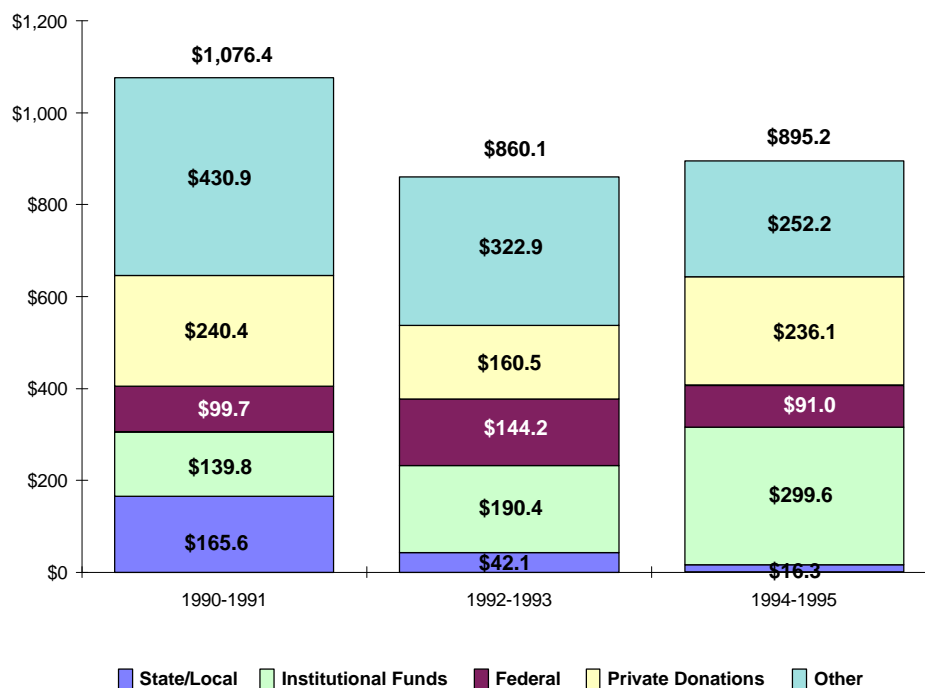


SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Public universities in the top 100 received half of their construction funding from state and local governments; public, other doctorate-granting institutions received 75 percent from this source; and the public, nondoctorate-granting institutions received virtually all (99 percent) of their construction funds from state and local governments.

Private colleges and universities received very little funding from state and local governments to construct S&E research facilities (Figure 6). For the 1994-1995 fiscal years, the single largest source of funding for the construction of S&E facilities at private universities in the top 100 was institutional funds, which provided 37 percent of all S&E construction funding. For private, other doctorate-granting institutions, 79 percent of all S&E construction funding came from private donations. Private sources also provided the largest share of funding to private, nondoctorate-granting institutions (44 percent).

Figure 6. Trends in the Sources of Funding for S&E Research Construction Projects at Private Institutions: 1990-1995



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

With the exception of the private universities in the top 100, direct Federal funding to construct S&E research facilities was lower at all types of institutions, in both constant dollar terms and in relative terms, in fiscal years 1994-1995 than in 1992-1993. Funds from the Federal government used to defray the indirect costs of conducting Federally funded research are counted as institutional funding.

State and local governments also were the single largest source of funding for the repair/renovation of S&E research space in all three types of public institutions. The private, doctorate-granting institutions, both in the top 100 and others relied primarily on institutional funds, while the nondoctorate-granting institutions relied most heavily on private donations.

Deferred Construction and Repair/Renovation

The 1996 *Survey of Scientific and Engineering Research Facilities at Colleges and Universities* expanded a question asked for the first time in 1994, in order to determine construction and repair/renovation costs that institutions had deferred. The earlier effort requested information only about deferred capital projects that were included in approved institutional plans. In 1996, institutions reported separately the construction and repair/renovation costs for projects included in such plans, as well as for projects not included. Thus, while response was limited in

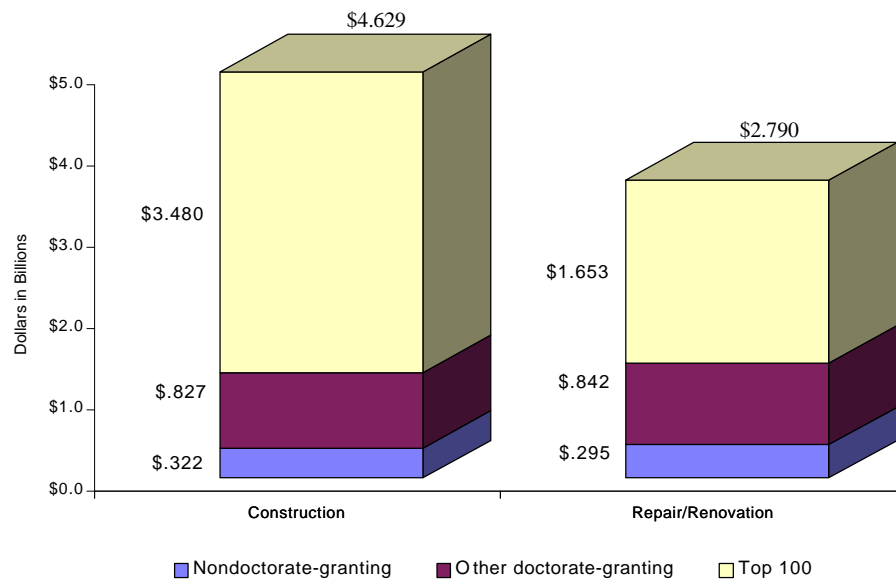
1994 to colleges and universities with institutional plans identifying deferred projects, all institutions were allowed to respond in 1996.

The total estimated cost for deferred S&E research construction and repair/renovation projects in 1996 was \$9.3 billion, including both projects that were in institutional plans and those that were not. Sixty-one percent of the deferred total (\$5.7 billion) was intended for the construction of S&E research space. The top 100 universities accounted for 71 percent of the total deferred construction and repair/renovation costs.

In addition, colleges and universities estimated a total of \$2.4 billion in deferred repair/renovation costs for projects affecting central campus infrastructure. Central campus infrastructure includes walkways and roads, wiring for telecommunications and electricity, sewers and drains, air handling, waste storage and disposal and the like. It is difficult to establish how much of this central campus infrastructure supports the work of S&E research compared with other academic or residential needs. Since 56 percent of all academic space is devoted to S&E, and 48 percent of that space is research space, a conservative estimate of S&E research needs for central campus infrastructure might be calculated as \$.7 billion. It should be recognized that (1) S&E research is probably more demanding of central campus infrastructure than other space, and (2) it is more difficult to prorate infrastructure costs than research facilities costs. Thus, \$.7 billion is a very conservative estimate of the S&E research infrastructure deferred project costs.

The 1994 report identified only projects which had been included in institutional plans, while the current report separately analyzes projects included and not included in institutional plans. Over three-quarters of all deferred capital project expenditures reported by institutions in the current survey (79 percent or \$7.4 billion) were included in institutional plans. Figure 7 shows that of the \$7.4 billion in deferred capital project expenditures in 1996, \$4.6 billion were in construction costs, and \$2.8 billion were in repair/renovation costs. Between fiscal years 1994 and 1996, deferred capital project costs included in institutional plans increased \$1.2 billion, from \$6.2 billion to \$7.4 billion in constant dollars. The majority of this increase was in deferred repair/renovation costs (an increase of \$ 970 million, compared with an increase of \$ 259 million in deferred construction costs). The balance of the difference between the \$7.4 billion included in institutional plans and the reported facilities needs of \$9.3 billion is due to the inclusion of \$1.9 billion in deferred projects not included in institutional plans. If combined with the conservative estimate of \$.7 billion in deferred infrastructure costs that can be attributed to S&E research, the total deferred facilities and infrastructure needs of colleges total \$10.0 billion.

Figure 7. Unfunded Science and Engineering (S&E) Research Facilities Needs Included in Institutional Plans: 1996



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Historically Black Colleges and Universities

For over a century, Historically Black Colleges and Universities (HBCUs) have played an important role in the education of black students in the United States. Over 282,000 students attended the 107 colleges and universities considered to be HBCUs in the fall of 1993. Although many of the HBCUs are relatively small and have considerably less S&E research space than other research-performing institutions, they award a disproportionate number of bachelor's degrees in the sciences. In 1990, for example, HBCUs enrolled only 17 percent of all black college students, but they awarded 44 percent of all bachelor's degrees in the sciences that went to black students (*Academe*, January/February 1995).

In 1996, the 68 research-performing HBCUs contained 9 million NASF of S&E space, with 26 percent of that space used for research. This space was most likely to be found in the biological sciences outside of medical schools (97 percent of the HBCUs reported space in this field) and in the physical sciences (79 percent).

HBCUs were most likely to indicate that they needed additional S&E research space in the computer sciences (57 percent reported this to be the case). In 1996, at least half of the HBCUs reported an inadequate amount of S&E research space in engineering (56 percent) and in the biological sciences outside of medical schools (50 percent).

Fourteen percent of the S&E research space in HBCUs (336,000 NASF) was evaluated as requiring major renovation or replacement.

The amount spent to construct S&E research space at the research-performing HBCUs declined dramatically, from \$30.2 million (in 1995 constant dollars) in 1992-1993, to \$21.3 million in 1994-1995. Repair/renovation expenditures increased from \$9.6 million in 1992-1993 to \$22.0 million in 1994-1995.

HBCUs reported a total of \$302 million in S&E capital projects that were needed but had to be deferred because there was not sufficient funding available. These included \$196 million in projects to construct S&E research space and \$106 million to repair/renovate existing S&E research space.

Nondoctorate-Granting Institutions

Many scientists and engineers receive training at research-performing institutions that do not award doctoral degrees. The visibility of these institutions has increased in recent years as policy makers recognize the contributions of these institutions to the production not only of practicing scientists and engineers, but of science and mathematics teachers for our nation's elementary and secondary schools.

In 1996, the nondoctorate-granting institutions contained 29 million NASF of S&E space. The comprehensive universities (those that offer a liberal arts program along with other programs such as engineering and business) accounted for 83 percent of the total S&E space among the nondoctorate-granting institutions.

In 1996, the biological sciences outside of medical schools and the physical sciences accounted for half of the S&E research space in the nondoctorate-granting institutions. In the liberal arts colleges, each of these fields occupied .5 million NASF. Together, the two fields accounted for 71 percent of the total 1.4 million NASF of S&E research space at those colleges.

Comprehensive universities evaluated 19 percent of their S&E research space (836,000 NASF) as needing major renovation or replacement. Liberal arts colleges reported 17 percent of their S&E research space (238,000 NASF) to be in the same condition.

To construct S&E research space, the nondoctorate-granting institutions spent \$330.6 million in fiscal years 1994-1995. Comprehensive universities accounted for 89 percent (\$294.5 million) of the S&E construction dollars among the nondoctorate-granting institutions. Another \$76.8 million was spent to repair/renovate existing S&E research space, with comprehensive universities accounting for \$51.1 million (66 percent) of total repair/renovation dollars.

Nondoctorate-granting institutions reported \$772 million in capital projects that were needed but had to be deferred because sufficient funding was not available. Forty-seven percent of these costs were for construction projects, while the balance (53 percent) was for repair/renovation projects.

Animal Care Facilities

To ensure the safekeeping and proper use of animals in research, Congress has provided guidelines for their humane care. The 1996 facilities survey gathered information on the amount of animal research space, the extent to which it meets government regulations, and the amount of construction and repair/renovation activity undertaken.

In 1996, 88 percent of the research-performing institutions had laboratory animal facilities. Most of the 12.2 million NASF of animal research space (93 percent) was contained in the doctorate-granting universities. Two-thirds of the animal research space was used to house animals and one third was considered animal laboratory space.

Institutions with animal research space reported that about 10 million NASF of that space (82 percent) met government regulations in 1996. Another 1.2 million NASF (10 percent) needed limited repair/renovation to meet those regulations; and 1.1 million NASF (9 percent) needed major repair/renovation to meet regulation requirements.

Only 6 percent of the research-performing institutions with animal research facilities were scheduled to construct animal facilities in fiscal years 1996-1997. Thirteen percent were scheduled to repair/renovate such facilities. However, the construction costs were almost double the repair/renovation costs: \$164.1 million to construct animal research space and \$83.3 million to repair/renovate existing space.

Introduction

Background

Since 1986, the National Science Foundation (NSF) has collected data on issues related to science and engineering (S&E) research facilities in U.S. colleges and universities. Conducted biennially, the *Survey of Scientific and Engineering Research Facilities at Colleges and Universities* has provided information on the availability and condition of S&E research space, the extent to which colleges and universities construct facilities and repair existing space, the funding of this activity, and the need for additional S&E research space.

The impetus for this effort stems from hearings held in both the U.S. House of Representatives and the Senate in the mid-1980s. These hearings concluded that the condition of S&E research facilities in our nation's higher education institutions posed a "serious and ongoing problem." Very little data were available, however, to evaluate either the extent of the problem or the likelihood of the problem continuing.

Recognizing the need for information on the amount and quality of S&E research space, Congress mandated that NSF gather this information and report it to Congress:

The National Science Foundation is authorized to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities and colleges. The needs of universities by major field of science and engineering, for construction and modernization of research laboratories, including fixed equipment and major research equipment, shall be documented. University expenditures for the construction and modernization of research facilities, the sources of funds, and other appropriate data shall be collected and analyzed. The Foundation, in conjunction with other appropriate Federal agencies, shall report the results to the Congress. The first report shall be submitted to the Congress by September 1, 1986 (42 U.S.C. 1886).

NSF submitted a report to Congress in 1986, and additional reports were submitted in 1988, 1990, 1992, and 1994. In each of those years, surveys were conducted to provide NSF with the information Congress requested. This 1996 report summarizes the findings of the 1996 survey, and it compares results with previous years.

The Survey and Its Design

The 1996 *Survey of Scientific and Engineering Research Facilities at Colleges and Universities* collected data to address a number of questions regarding S&E research space, including the following:

- ◆ How much S&E research space is available in our nation's colleges and universities?
- ◆ Is the current amount of S&E research space sufficient?
- ◆ What is the condition of existing S&E research space?
- ◆ To what extent are colleges and universities constructing S&E research space?
- ◆ To what extent are colleges and universities repairing and renovating their current S&E research space?
- ◆ Who is funding the construction and repair of S&E research space?
- ◆ What is the need for additional S&E research space as well as the need to repair or renovate current space?

Since the survey was initiated in 1986, attention has focused on providing Congress with trends on S&E research facilities issues. Slight changes have been made to the survey, however, in each of the data collection cycles. In 1996, the survey added questions to determine the extent to which colleges and universities needed more S&E research space and were renovating or replacing existing space. Questions also were added to determine the central campus infrastructure needs of colleges and universities.

In addition, the 1996 survey modified both the wording of some questions and the possible responses. Changes made were in response to new concerns of NSF and Congress, as well as concerns of institutional respondents and advisory panel members representing the higher education community. (Specific changes are noted at the beginning of each chapter in the section, "Data Considerations.")

The sample for the 1996 survey was designed to provide efficient and unbiased estimates of the amount of S&E research space in colleges and universities and to retain comparability with the 1992 and 1994 sampling procedures. The 1996 sample, like the 1994 sample, represented all institutions with more than \$50,000 in research and development (R&D) expenditures as well as Historically Black Colleges and Universities (HBCUs) with any R&D expenditures. The 1996 sample represented 560 such institutions, referred to as research-performing institutions throughout this report.

Most sampled institutions were selected with a probability proportional to the square root of their R&D expenditures in thousands. (See Appendix A, “Technical Notes,” for a more complete discussion of sampling procedures.) The final sample of 314 colleges and universities, which represented the universe of 560 research-performing institutions, included the following:

- ◆ All of the top 100 colleges and universities in terms of R&D expenditures (n=100);
- ◆ Other public, doctorate-granting universities (n=53);
- ◆ Other private, doctorate-granting universities (n=35);
- ◆ Public, nondoctorate-granting institutions (n=69); and
- ◆ Private, nondoctorate-granting institutions (n=50).

The HBCUs were included in the above categories.

The 1996 survey was mailed to all sampled institutions in the fall of 1995. For the first time, both a paper copy and a Windows-based disk version of the survey were included in the mailing. Respondents could thus record answers in either format.

Institutions that participated in the 1994 survey also were sent a computer-generated “facsimile” of their previous responses. Extensive telephone follow-up elicited a high response rate and reduced the number of items that respondents had initially omitted or responded to inconsistently. In all, 97 percent of all sampled institutions completed the survey. Of those, 27 percent chose to use the diskette and 73 percent filled out the paper version of the survey.

The Report

The 1996 report follows the basic format of the 1994 report, and each chapter contains the following sections:

- ◆ **Highlights**--a summary of key findings;
- ◆ **Background**--the rationale and context for the findings presented in the chapter;
- ◆ **The Survey Question(s)**--a description of the question or questions that the chapter focuses on;
- ◆ **Data Considerations**--a presentation of data limitations or interpretations; and
- ◆ **Findings**--tables, graphs, and texts that address questions frequently posed about S&E research facilities.

Most chapters present differences by type of institution and S&E field. The categories used to define type of institution are:

- ◆ Doctorate-granting, which includes
 - ⇒ The top 100 institutions in R&D expenditures
 - ⇒ The other doctorate-granting institutions not in the top 100
- ◆ Nondoctorate-granting

For this survey and report, the following S&E fields are included:

- ◆ Biological sciences outside of medical schools
- ◆ Physical sciences
- ◆ Psychology
- ◆ Social sciences
- ◆ Mathematics
- ◆ Computer science
- ◆ Earth, atmospheric, and ocean sciences (formerly environmental sciences)
- ◆ Engineering
- ◆ Agricultural sciences
- ◆ Medical sciences, outside of medical schools
- ◆ Biological sciences, in medical schools
- ◆ Medical sciences, in medical schools

In addition, a chapter on HBCUs and a chapter on nondoctorate-granting colleges and universities profile S&E research facilities issues in these institutions.

Expanding an effort made for the first time in 1994, the 1996 report also includes an expanded chapter on research facilities needs of colleges and universities. Finally, a chapter on animal care facilities is presented.

Chapter 1 presents findings on the amount of research space in S&E fields at research-performing institutions. Chapter 2 examines assessments of the adequacy of the amount of S&E research space, as well as its condition. Chapter 3 provides costs in constant dollars on the construction of S&E research facilities. Similarly, Chapter 4 provides costs in constant dollars for the repair/renovation of S&E research space. Chapter 5 examines the sources of funds for the capital projects described in Chapters 3 and 4.

Chapter 6 examines the needs of institutions for additional S&E research space, as well as the need for repair/renovation of existing space. Chapter 7 profiles S&E research space at HBCUs, and Chapter 8 profiles nondoctorate-granting institutions. The final chapter, Chapter 9, presents data on animal care facilities.

The 1996 report also contains five appendices:

- ◆ Appendix A, “Technical Notes,” presents additional details about the study design and methodology;
- ◆ Appendix B, “List of Sampled Institutions,” provides the names of all colleges and universities in the sample;
- ◆ Appendix C, “Questionnaire,” provides the paper copy of the 1996 instrument;
- ◆ Appendix D, “Reference List,” contains the full citation for all references used in this report;
- ◆ Appendix E, “Validation of Estimates of Deferred Project Costs,” tests an alternative method for estimating deferred project costs; and
- ◆ Appendix F, “Detailed Statistical Tables,” presents additional tables not included in the chapters.

Taken as a whole, the information prepared for this report will shed light upon building and maintaining research space in science and engineering at colleges and universities.